

THE SURFACE NETWORK

An energy and logistics infrastructure for a permanent lunar base

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Abstract

Building a permanent lunar base requires more than isolated missions and heroic vehicles. It needs infrastructure. This paper proposes the Surface Network: an energy, logistics, and data network built on the Moon itself by interconnecting the landers as they arrive.

Each lander, instead of dying of success, becomes an infrastructure node: it contributes energy, heat, storage, avionics, and pumping capacity to the whole. Connected by a multi-tubular hose that transports fluids, electricity, and data, the landers form a distributed propellant depot, a redundant electrical grid, and a collective thermal management system.

The network is resilient (does not depend on individual nodes), scalable (grows with each new lander), flexible (reconfigurable in hours), replicable (can be established anywhere on the Moon), and acts as a transport platform for long-distance exploration.

Beyond technology, this paper distinguishes four levels of abstraction — concept, model, implementation, and execution — and places its contribution in the first two. The Surface Network is not a closed design but a logical structure with its own emergent properties, independent of hardware or scale.

The network is not an end. It is a means to something that does not yet exist but which we can already glimpse: a multi-planetary civilization that understands that its future is built not with missions but with infrastructure; not with visits but with permanence.

Keywords: surface network, lunar infrastructure, permanent lunar base, infrastructure nodes, standardization, resilience, scalability, space logistics.

1. Introduction

As I set out in my article *The Bidirectional Lunar Logistics Network*, we are living through a historic window of opportunity in space exploration. For the first time, three factors coincide that have never occurred together:

- a new space race focused on the Moon and permanent presence,
- giant reusable rockets capable of launching tens or hundreds of tons at low cost,
- mature, robust, proven technologies that allow operating in space with unprecedented reliability.

This combination changes everything. For the first time, building lunar infrastructure ceases to be science fiction and becomes a realistic, economically viable, and technologically accessible project.

However, we continue to approach the problem with a mental framework inherited from the Apollo Program: isolated missions, heroic vehicles, unique flight profiles, landers that go up and down once and then die of success. That approach no longer works.

If our goal is a permanent lunar base — a continuous human presence, not a camp visited occasionally — we must recognize the magnitude of the challenge. We continue to design isolated missions focused on science and exploration, valuable in themselves, but which leave behind a cemetery of successful landers and a collection of scattered rovers. That is not infrastructure. That is not permanence.

The effective occupation of a territory is not achieved by repeating the pattern of the Surveyor missions or the Apollo Program. We already did the exploration, and we did it well. What is missing now is what was never attempted: **permanent infrastructure**.

And if we want to stay on the Moon — not just visit it — we must change the fundamental question:

Not "how do we build a habitat to visit the Moon?" but "**what system allows us to build a permanent and scalable energy infrastructure?**"

The answer is clear: we do not need a perfect lander, nor a perfect rocket, nor a perfect mission.

We need a network. A **Surface Network**.

A network built on the lunar surface that interconnects every lander that arrives on the Moon. A network that is the energy and logistics heart of the lunar base. A permanent, scalable, redundant, and resilient network. A network that turns every kilogram placed on the surface into infrastructure. A network that moves fuel, heat,

energy, and data. A network that works every day and turns the Moon into an accessible place, not an exotic destination.

2. Mission Architectures vs. Infrastructure Networks

Contemporary space architectures have mostly been developed under a **mission paradigm**. In this approach, each operation is conceived as an isolated event, individually optimized to maximize performance within a closed set of constraints. This model was extraordinarily effective during the initial phase of space exploration, when objectives were punctual, resources limited, and repetition was not a requirement.

But this same approach reveals **deep limitations** when evaluated from the perspective of sustained operations.

In a mission architecture:

- each flight is independent,
- the resulting infrastructure is minimal or non-existent,
- valuable resources are abandoned on the surface, forming a "cemetery" of landers that die as soon as their mission ends,
- and optimization focuses on a single device: a research lander, an exploration rover, a specific module.

In previous articles, I highlighted the importance of the **Appian Way** and the logistics network in the expansion and permanence of the Roman Empire. But I omitted another equally decisive factor: **infrastructure**. Rome not only built roads; it also built aqueducts, ports, warehouses, cities, markets, and manufacturing industries. It built **interconnected systems**. Isolated missions do not build infrastructure. They can explore, they can demonstrate capabilities, they can leave valuable instruments. But **if they do not connect to each other, they die**.

In contrast, a **persistent surface network** introduces a fundamental conceptual shift. The system ceases to be defined by isolated elements and becomes defined by the **interaction of the whole**.

In this framework:

- each added element integrates into the existing network,
- no component remains isolated or condemned to survive on its own,
- and the existence of nodes, intermediate storage, and shared resources becomes the dominant factor.

Performance no longer depends on optimizing an individual component, but on the **collective dynamics** of all of them.

This change completely alters the relevant variables.

Risk management also changes. In isolated structures, a failure means total loss of the device. In a surface network, risk is distributed among multiple components. Individual failures can be absorbed without compromising system continuity, as long as the infrastructure remains intact.

Furthermore, logistics networks facilitate **technological evolution**. While an architecture based on independent elements remains anchored to initial decisions, a persistent network allows new technologies to be incorporated progressively, without redesigning the entire system. Infrastructure acts as an integration platform.

From an economic perspective, the difference is even more marked. Architectures based on independent components have high costs per unit mass because each element must guarantee its survival in a hostile environment by itself, without external support. In surface networks, standardization and reuse of existing infrastructure reduce cost as a natural consequence of continuous operation.

For all these reasons, moving from architectures of isolated components to **surface networks** is not an incremental optimization: it is a **paradigm shift**.

It is not about designing the best individual component. It is about building a system capable of sustaining activity over time.

And this distinction is fundamental:

- **Research and exploration can be achieved through individual missions and structures.**
- **The effective and permanent occupation of the lunar surface requires infrastructure networks.**

3. Energy Infrastructure as a Condition of Possibility

If we want the declared objective of current lunar programs — the establishment of a **Permanent Lunar Base** at the South Pole — to stop being an aspirational dream and become an operational reality, we need to build the **permanent infrastructures** that enable sustained habitability over time.

And the fundamental infrastructure that underpins all others is **energy infrastructure**.

This statement is so obvious that it hardly requires explanation: any system placed on the lunar surface that does not receive energy — or cannot generate it by itself — is doomed to functional death. Every activity, from the mere survival of an astronaut to the operation of a scientific instrument, depends on energy availability. Therefore, the first and most important infrastructure we must build is the one that guarantees a **permanent energy supply**.

At this point, it is necessary to take a clear position. From my point of view — and fully aware that this is a personal opinion — **without an operational nuclear reactor on the Moon, there cannot be a Permanent Base in the strict sense** [1][2].

Complementary alternatives could be considered: hydrogen and oxygen storage to power fuel cells [3], solar panel fields, high-capacity battery modules. All of them can provide redundancy and flexibility. But without nuclear reactors as the primary source of energy and heat, what we will have is not a permanent base, but a **temporary camp**, visited occasionally by astronauts and accompanied by a collection of scattered rovers. And little more [4].

A continuously inhabited lunar base requires a **constant, abundant, and secure** energy supply. Any interruption in that supply is, literally, a death sentence.

4. What Are the Requirements and Components Needed to Supply Energy to a Permanent Lunar Base?

I do not intend to dwell here on a subject to which I have little to contribute. I do not have the preparation, experience, or means to propose — let alone size — a project of such magnitude. And even if I did, it is work that can only be tackled by multidisciplinary teams of top-level scientists, engineers, and technicians, working for years with adequate resources. Therefore, I will not speculate on fine engineering.

But we can establish something fundamental: **any lunar energy system will need, as a minimum, the following elements:**

- fuel and propellant storage tanks,
- batteries to accumulate electrical energy,
- radiators to dissipate excess heat,
- solar panels for complementary production,
- an electrical grid,
- computers, avionics, and communication systems,
- a data network,
- a distribution system with circulating pumps and pipes,
- helium tanks for pressurization,

- support and protection structures for all these elements.

The magnitude of this list makes the challenge clear: building, transporting, and assembling a complete energy infrastructure on the Moon requires a colossal investment of resources. At first glance, it seems a distant goal.

And it probably is, **if we approach it from the traditional paradigm of infrastructure construction**: large modules, in-situ assembly, dedicated systems, unique installations.

That is why it is necessary to adopt **another perspective**.

I am not proposing a closed solution. I am presenting a **conceptual framework** and the **physical principles** that make it viable. Detailed engineering is the responsibility of those who have the resources, the mandate, and the responsibility to build it.

Join me, then, in discovering this **Surface Network**.

5. Building the Surface Network

If we look carefully at the list of elements needed to build the energy infrastructure of a lunar base, a notable coincidence appears: **all those components are already present in every lander that descends to the lunar surface**. But this is not a coincidence. It is a **convergence**.

The same hostile environment, the same operational and survival needs, the same thermal, energy, and logistical demands mean that landers incorporate — from their manufacture — exactly the same subsystems that a lunar base would need to function.

This raises an uncomfortable question:

Would it not be a tragic irony to let a lander "die of success" on the lunar surface, only to later transport the same elements that lander already brought integrated?

With the cost — economic, energy, and logistical — of putting a single kilogram on the lunar surface, **can we afford to waste tons of already delivered infrastructure?**

Why not take advantage of the resources the lander itself provides?

From this reflection emerges the central idea of this paper: the **Surface Network**.

Instead of conceiving each lander as a disposable vehicle whose sole purpose is to deliver cargo and then become space junk, we can **redefine it as an infrastructure node**. Each lander stationed on the lunar surface can be integrated into a network that connects:

- its energy,
- its thermal capacity,
- its storage,
- its avionics,
- its pumping capacity,
- its transfer ports,
- its communication systems,
- its structures and protections.

Each one contributes what it has. The network turns them into something greater than the sum of their parts.

Thus, what was once a cemetery of isolated Landers is transformed into a **distributed infrastructure**, capable of sustaining operations, powering systems, distributing heat, moving propellant, and serving as the backbone of a permanent lunar base.

The Surface Network is not an accessory. It is the **fundamental energy and logistics infrastructure** upon which any sustained human presence on the Moon can be built.

6. The Topological Basis of the Network

Every network consists of nodes. In our case, the nodes are the **landers stationed on the lunar surface**. And the **initial seed** of the entire network will be the lander that carries a **nuclear reactor**.

We will not go into the details of the reactor. Any of the options currently under consideration — Kilopower, Fission Surface Power [5], Rolls-Royce Space Micro Reactor [6] — is nothing more than a **specific implementation** of the network. One possible model. What interests us here is the **concept**, not the fine engineering.

The reactor must be the seed because it is the element that **prevents the network from dying**. For every kW of electricity it produces, it generates between 2 and 3 kW of waste heat. If the reactor were isolated on the lunar surface, that heat would have to be dissipated through dedicated radiators, which would have to be manufactured, transported, and assembled.

That waste is unacceptable.

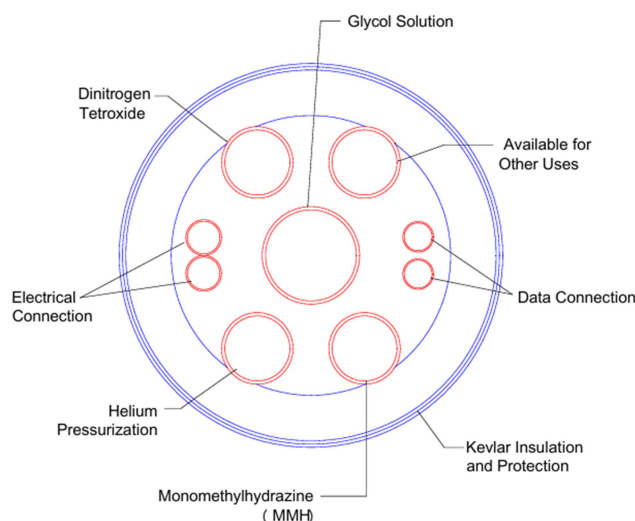
Instead of radiating it into space, we will use that heat to **keep all landers connected to the network warm and operational**, as well as any other device integrated into it. And the excess heat will be dissipated through the **radiators that the landers themselves already incorporate**.

Thus we obtain the network nodes. Now we need to **connect them**.

And we will do so through **a hose**.

7. Building the Network

To build the network we must connect the nodes. The fundamental tool will be a **multi-tubular hose** designed to operate for years on the lunar surface.



Each lander will be equipped with **at least four interconnection ports**, allowing it to be linked with neighboring landers. The hose will contain:

at its core, a flexible pipe approximately **30 mm in diameter** for the circulation of the glycol solution heated by the reactor, around it, conduits for **N₂O₄, MMH, pressurization helium**,

- an **electrical cable** for power distribution,
- and a **data link** for communication and synchronization.

The entire assembly will be protected by layers of insulation, Kevlar, and other materials that engineering deems appropriate. The list is not closed: it is a **minimum orientation**. Different versions of the hose could even exist depending on the assigned function.

I propose that these hoses be buried in the regolith. The regolith is an excellent thermal insulator and a natural protector against micrometeorites and radiation [7]. Although not strictly necessary in the early stages, it is an obvious improvement in terms of durability.

This architecture allows the landers themselves to function as a **distributed propellant depot** on the lunar surface, avoiding the need to build one from scratch. Circulating fluids will be pumped by the **already integrated pumps** in the landers, providing redundancy and immediate availability. The technology for such a system, including a flexible multi-tubular hose, quick disconnects (QD), and robotic tools for connection, was developed, tested, and validated by NASA on the ground for its OSAM-1 mission [8].

The electrical cabling will act as a **redundant backbone network**, allowing energy circulation between nodes. The solar panels of each lander will provide additional energy at no extra cost, and surpluses will be stored in the already installed batteries.

The data connection will allow **sharing of computing and communication resources**. Here it is worth speculating to illustrate the potential of the network:

- If each lander incorporates triple computer redundancy — common in long-duration missions — that redundancy can become **computational capacity available to the lunar base**.
- A network of distributed antennas with millimetrically known positions could operate as a **lunar interferometer**, enabling radio astronomy experiments impossible from Earth.
- Three beacons integrated into three different landers allow building a **proximity GPS** with millimetric precision for future landing and navigation operations.

These ideas are not closed proposals. They are examples of the fundamental principle: **a network is always more than the sum of its parts**.

Two clarifications are necessary.

First: no one has yet designed a hose and connection ports intended to operate for years on the lunar surface. The regolith is abrasive and poses real challenges. But any lunar base architecture — including the most traditional — will need pipes and connections for fluid circulation. The problem is unavoidable.

Second: the construction and operation of this network is a considerable engineering challenge. But no greater than other challenges we already consider resolved or resolvable in the short or medium term: combating boil-off for months, handling liquid hydrogen in space, operating cryogenics in deep vacuum. If we trust that our engineers will solve those problems, we can also trust that they will solve those associated with this network.

8. The Plug & Play Network

One of the most significant advantages of the Surface Network is that it offers **plug & play connectivity** for all its nodes. Any lander integrated into the network — and sharing its resources with it — can be **refueled with propellants**, temporarily disconnected, and reassume its transport functions.

This includes:

- moving empty to **Node_LLO**, the orbital propellant and cargo depot in low lunar orbit,
- picking up cargo, being refueled, and returning to the surface,
- or transporting cargo from the lunar surface to the orbital depot for subsequent shipment to Earth.

In other words: **the landers that form the network maintain full operational capability**. They can connect and disconnect without losing their primary transport function.

This connectivity enables **near-instant reconfiguration** of the network. If we wish to incorporate an ISRU module, it is enough to factory-mount it on a lander, test it under controlled conditions, and send it to the Moon ready to operate. Once on the surface, it is only necessary to **connect the hoses** to integrate it into the network. No deployment. No assembly. No in-situ construction. Just connection. *Plug & play*.

And if at any time we need to move that module or relocate it elsewhere, we simply refuel the lander, disconnect the hoses, and send it to its new destination.

The same applies to:

- new reactors,
- solar arrays,
- electrolysis plants,
- water storage tanks,
- cryocoolers,
- or any other subsystem.

Everything can be integrated without complex operations on the lunar surface. **Just by connecting some hoses.**

Furthermore, the network offers a natural final destination for any lander that has completed its useful life cycle or suffered damage that disables it as a transport vehicle. Instead of swelling the lander cemetery, it **remains as a fixed node of the network**, contributing its energy, thermal, structural, and logistical resources.

This is the simplest, most robust, and most efficient way to expand infrastructure in an environment extremely hostile to human work: **the network grows by adding nodes.**

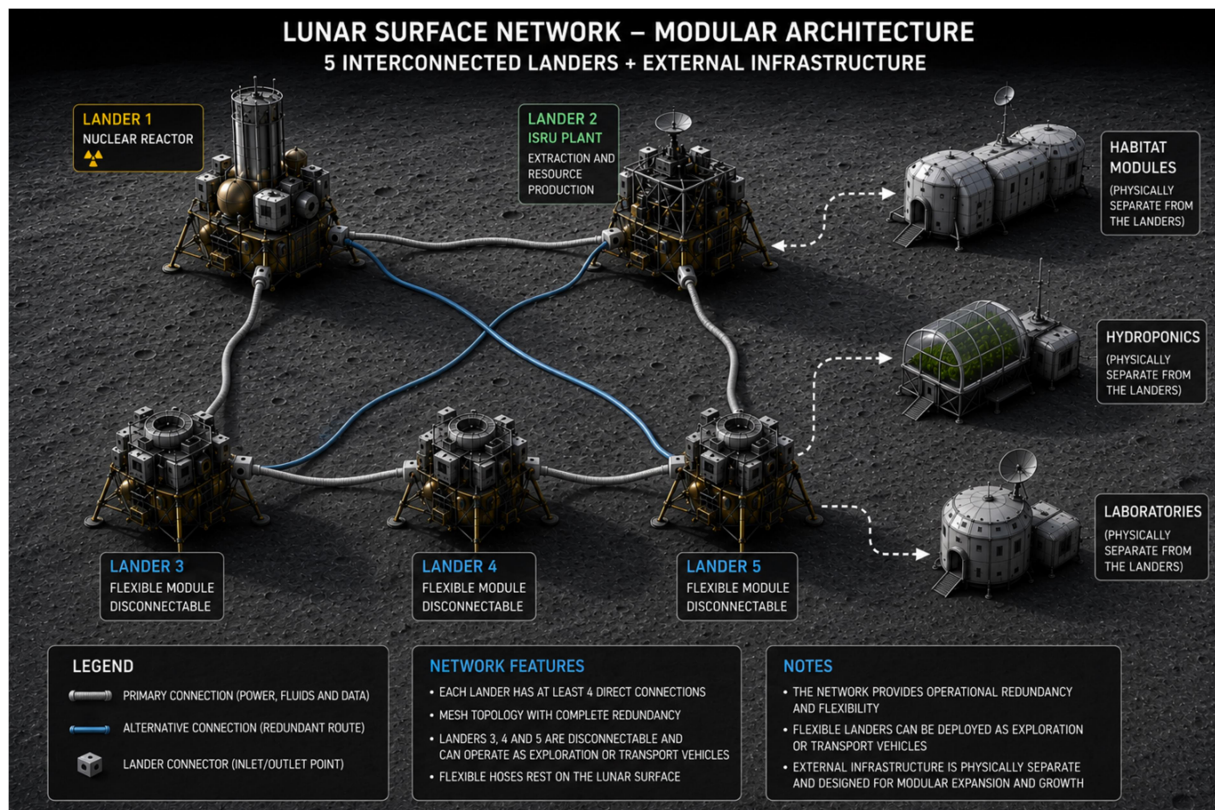


Figure 1: Conceptual diagram of a Lunar Surface Network with 5 interconnected landers. Landers 1 and 2 are fixed nodes (nuclear reactor and ISRU plant). Landers 3, 4, and 5 are flexible, disconnectable modules that can be deployed as exploration or transport vehicles. Redundant connections guarantee system resilience.

9. Properties of the Surface Network

Resilience

This property is so obvious it hardly requires explanation. Once the network reaches a minimum degree of development — for example, the connection of more than one nuclear reactor — it becomes **practically indestructible**. The loss of one node does not affect the rest. With an adequate arrangement of cut-off valves, check valves, and thermal and electrical fuses, any damage can be **isolated and rerouted** to other nodes.

The network does not depend on a single critical point. By definition, it is **resilient**.

Scalability

Each lander destined for the Moon automatically becomes a **new node**. The network grows naturally with each mission. To incorporate new resources or capabilities, it is enough to send a dedicated lander and connect it. No complications. Clean, fast, and safe.

Flexibility

The network configuration can be modified simply by adding or removing nodes, or by altering the hose connections. All these operations can be performed with **minimal or zero human intervention** on the lunar surface.

Replicability

The network is **reproducible** anywhere on the Moon. If a valuable resource is discovered in another region, it is enough to send:

- a lander with a Kilopower reactor,
- and other landers with the equipment needed to exploit the resource.

The network is established immediately, providing energy, heat, propellants, and communications from the first day.

Transport Platform

The Surface Network is, by its very nature, a **logistics mobility platform**. Adding nothing, at no additional cost, without modifications.

A refueled lander can transport:

- a rover,
- a pressurized module,
- or any cargo,

hundreds of kilometers away. And by establishing small local networks along the route — intermediate nodes with hypergolic propellants — it enables exploration of **thousands of kilometers** of the lunar surface.

A simple, redundant, safe, and scalable logistics and energy network.

10. Compatibility and Standardization

The Surface Network establishes, de facto, **the operational standards for working on the Moon** [9]. And this is decisive: without standards there is no industry, no private investment, no expansion. There are only heroic missions and unique vehicles that die of success. No state agency, no matter how large, can sustain a permanent infrastructure on the Moon by itself.

To move from exploration to the **effective occupation of lunar territory**, we need to bring in actors: universities, research centers, private companies, service providers.

But no one can participate if they must first invent their own rocket, their own lander, their own energy network, their own supply infrastructure.

History is clear: revolutions do not occur when a technology appears, but when that technology **becomes standardized**.

At the end of the 19th century, every factory had to build its own power plant. The true industrial revolution was not the light bulb: it was **the plug**. When energy became a service, companies stopped worrying about generating it and started using it to innovate [10].

The Surface Network fulfills the same role on the Moon. It offers **immediate connectivity** for any industrial, energy, or scientific module, without complex deployments or in-situ assembly. But it demands something in return: **compatibility**.

Standardization allows:

- reducing costs and errors,
- ensuring that components from different manufacturers work together,
- opening the door to startups and new actors,
- protecting the integrity of the network,
- accelerating innovation on a common base.

As I developed in my previous article, **The Bidirectional Lunar Logistics Network**, logistics standardization in low orbit is the necessary condition to enable massive, economical, and repeatable transport between Earth and the Moon.

The Surface Network is its natural complement.

- The orbital network standardizes **transport**.
- The surface network standardizes **operation**.

Together they form a complete logistics ecosystem, from Earth to any point on the lunar surface.

A coherent, scalable, and accessible system for multiple actors.

The Moon ceases to be an exotic destination and becomes an **industrial environment**.

Anyone who wants to participate no longer has to solve logistics or energy: they can focus on their own business.

But let us not forget that standards are set by **those who get there first** [12].

"Hello, good morning. I need to send two excavators and some spare parts to Tsiolkovsky crater within two months. Can you give me a quote?"

Today it sounds like irony. Tomorrow it could be a real phone call.

11. Concept, Model, and Implementation: The Immaterial Nature of Networks

To fully understand the nature of the networks proposed in these articles — the Bidirectional Lunar Network and the Surface Network — it is necessary to distinguish precisely the **levels of abstraction** at which each operates. This distinction is not a methodological detail: it is the key to understanding which part of these ideas is universal and which is contingent.

11.1. The Conceptual Level, the Idea

Networks are not hardware. They are not a design. They are not a set of parts. **Networks are a concept.**

A robust concept can be represented by models, implemented through engineering, and executed physically in the lunar environment. But each level has its own properties, responsibilities, and degrees of freedom.

Up to this point, we have described both networks in operational terms — nodes, connections, energy, propellants, data, mobility — but it is fundamental to clarify their essence: **a network is, above all, an immaterial idea**, a mental framework, a logical structure for organizing resources, flows, and capabilities. An abstract architecture that exists independently of the devices that implement it.

Hardware — landers, reactors, pipes, pumps, antennas — is just a physical manifestation of the concept. One possible form among many. A contingent implementation, not the network itself.

Both the Bidirectional Lunar Network and the Surface Network possess emergent properties that do not depend on the size of the landers, the type of reactor, the manufacturer, the propellant, the hose design, or any specific technology. Resilience, scalability, redundancy, flexibility, and standardization do not come from hardware, but from the **conceptual structure** of the network.

A network is more than its components: **it is the relationship between them.**

11.2. Models: Possible Representations of the Concept

From the concept, **models** can be built. A model is a concrete representation, a way of materializing the idea in a set of physical elements or operational parameters.

A model can use hypergolic landers, another cryogenic ones; one can be based on Kilopower reactors, another on European modular reactors; one can employ solar panels and batteries, another rigid pipes instead of flexible hoses. All are valid if they respect the fundamental principle: **an interconnected network that shares resources and builds permanence.**

11.3. Implementations: The Domain of Engineering

Implementation is the translation of the model into real hardware. Here, engineers, technicians, manufacturers, agencies, budgets, materials, tolerances, protocols, and certifications come into play. It is the level where decisions are made about the diameter of a hose, the alloy used, the pump that drives the glycol, the protocol used by the data network, the valves installed, or the reactor mounted on which lander.

This level **is not the objective of this paper**, nor does it correspond to my capabilities or my role. I do not intend to canonize any specific implementation.

11.4. Execution: Physical Operation

Execution is the actual construction and operation of an implementation. Here, astronauts, robots, lunar dust, wear and tear, maintenance, schedules, budgets, real failures, and daily logistics intervene. It is the most contingent level, the most dependent on physical reality, and the least relevant to theory.

11.5. The Key: Each Level Has Its Own Emergent Properties

- The oscillations and attractor of the Lunar Network → **emerge from the concept.**
- Carrying capacity and performance → **emerge from the model.**
- Costs → **emerge from the implementation.**
- Real failures and operability → **emerge from the execution.**

This separation is what allows constructing a general theory, independent of hardware and time.

11.6. The Relationship Between Both Papers

In *The Bidirectional Lunar Logistics Network*, I developed the idea of an orbital logistics network capable of moving cargo, propellants, and energy between Earth and the Moon efficiently, scalably, and in a standardized way.

In this paper, the Surface Network fulfills the same role in the lunar domain: it is the energy and logistics infrastructure that allows operating, expanding, and inhabiting the surface.

Both networks express the same philosophy:

Permanence is not achieved with missions. Permanence is achieved with networks.

One in orbit. Another on the surface. Complementary. Both necessary. Both independent of hardware. Both defined by their structure, not by their components.

12. Final Reflection: We Choose to Stay

In 1962, in a stadium in Houston, John F. Kennedy spoke words that marked an entire generation:

"We choose to go to the Moon... not because they are easy, but because they are hard."

Those words were not about rockets. They were about identity. About will. About a civilization that looked to the future with determination, taking risks and facing challenges because it understood that the only way to endure is to move forward.

Today, more than sixty years later, the Moon is once again before us. But not as a technical challenge or a symbol of national prestige. Today, the Moon is something deeper: **the first territory where we must decide whether we want to be a species that grows or a species that chooses the comfort of stagnation.**

Space is the new frontier. And facing a frontier, there are only two options: turn around or cross it. That decision is not made with a rocket or a lander. It is made with the collective will to move forward.

I must be honest: returning to the Moon with a remixed version of the Apollo Program is not, for me, crossing a frontier. It is staying on this side. Human presence beyond Earth cannot depend on heroic gestures, but on systems that outlive their

components. Continuity matters more than spectacle. Permanence is an act of responsibility, not conquest.

Apollo had a clear purpose: to take a human being to the Moon and plant a flag **where no one had ever been before**. It was the culmination of an exploratory spirit that came from afar. And it worked because everything — rocket, capsule, lander, industry — was aligned with that objective. But it was also a product of its time: a technological miracle sustained by an unrepeatable unity of purpose.

Artemis does not propose a paradigm shift. It is an architecture focused on the mission, not on systems. An expanded, more modern, 4K-resolution repetition, but without the structural ambition that permanence demands. A weekend excursion: we go, take photos, record a video for Instagram, walk among a cemetery of landers and a pack of rovers... and we return.

That bears no resemblance to the challenge issued by JFK. Perhaps that is why it does not arouse the emotion that Apollo did. People are usually intuitive about such things.

Today, technology is different. And the challenge is different too. Today, we must decide whether we choose to **stay**.

Not because it is easy. Not because it is profitable in the short term. Not because it is glamorous. But because it is the next logical step for a civilization that decides to expand with vision.

The Moon will not become our second home because we have better rockets. It will become our second home when **we have the will for it to be so**.

I will not repeat what has already been said: we have the necessary technology. We have the financial capacity. And we have investors willing to take risks if a serious framework exists to which they can attach themselves. Not everyone can build their own rocket or their own lander. But the fact that at least two can is a sign of how many more would join if a common infrastructure existed.

It is not technology or money that holds us back. It is the lack of vision. The absence of a clear goal. The weight of mental schemes that leave us standing at the frontier without deciding to cross it.

The networks I have described — the orbital and the surface — are not an end. They are a means. A means to something that does not yet exist, but which we can already glimpse: **a multi-planetary civilization that understands that its future is built not with missions but with infrastructure; not with visits but with permanence.**

The Moon will be our first dress rehearsal. And what we learn there will not be only for the Moon. It will be for Mars, for the asteroids, for any other world we decide to inhabit. But above all, it will be for ourselves.

Because building infrastructure on another world is, deep down, an act of introspection. It forces us to think long-term, about continuity, about cooperation, about intergenerational responsibility. It forces us to abandon the logic of the event and embrace the logic of the system.

We need ideas that allow permanence. Ideas that allow continuity. Ideas that allow today's effort not to die tomorrow.

Because, in the end, what is at stake is not the Moon. **It is us.**

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